

CLAIMS

We claim:

1. A bone graft suitable to augment a sinus, wherein the bone graft comprises synthetic material or demineralized bone matrix in a rigid form.
2. The bone graft of claim 1 wherein the bone graft is manufactured to a desired shape or desired dimensions.
3. The bone graft of claim 2 where the shape or dimensions are chosen based on dimensions of a particular patient.
4. The bone graft of claim 2 wherein the shape or dimensions are chosen based on radiographic data from a particular patient.
5. The bone graft of claim 1 wherein the bone graft has external surfaces facing adjacent natural bone in a patient, which have a defined spatial relationship with respect to the adjacent natural bone to within a tolerance of less than 0.4 mm.
6. The bone graft of claim 5 wherein the defined spatial relationship is a fit to within the tolerance.
7. The bone graft of claim 5 wherein the defined spatial relationship is a gap of a defined dimension, to within the tolerance.
8. The bone graft of claim 5 wherein the defined spatial relationship is an interference of defined dimension, to within the tolerance.

9. The bone graft of claim 5 wherein at some place the defined spatial relationship is a member selected from the group consisting of a gap, and a fit and an interference, and at some other place the defined spatial relationship is a different member selected from the same group.

10. The bone graft of claim 1 wherein the bone graft comprises more than one piece which together provide a desired shape.

11. The bone graft of claim 1 wherein the bone graft comprises at least one hole corresponding to an intended position of an implant base.

12. The bone graft of claim 1 wherein the bone graft comprises at least one hole corresponding to an intended position of an attachment device.

13. The bone graft of claim 1, further comprising at least one feature allowing the bone graft to be held by a gripping tool.

14. The bone graft of claim 1 wherein the bone graft comprises a matrix of particles joined to each other forming a three-dimensionally interconnected network.

15. The bone graft of claim 14 wherein the matrix has pores wherein the distribution of pore volume as a function of pore size has a mode between 10 micrometers and 25 micrometers.

16. The bone graft of claim 14 wherein the matrix has a porosity between approximately 0.2 and approximately 0.6 .

17. The bone graft of claim 14 wherein the matrix comprises particles of ceramic partially sintered directly to each other.

18. The bone graft of claim 14 wherein the matrix comprises particles of demineralized bone matrix joined to each other by a binder substance.

19. The bone graft of claim 14 wherein the matrix comprises particles of a polymer joined to each other.

20. The bone graft of claim 1 wherein the bone graft comprises a ceramic.

21. The bone graft of claim 1 wherein the bone graft comprises at least one substance selected from the group consisting of hydroxyapatite, tricalcium phosphate and other calcium-phosphorus compounds.

22. The bone graft of claim 1 wherein the bone graft comprises nonresorbable material.

23. The bone graft of claim 1 wherein the bone graft comprises resorbable material.

24. The bone graft of claim 1 wherein the bone graft comprises both nonresorbable and resorbable materials.

25. The bone graft of claim 1 wherein the bone graft comprises both nonresorbable and resorbable materials in different proportions in different places within the bone graft.

26. The bone graft of claim 1, further comprising channels which extend into an interior of the bone graft.

27. The bone graft of claim 1, further comprising channels or patterns on a surface of the bone graft.

28. The bone graft of claim 1 wherein the bone graft comprises a surface having a surface geometry which is different from a geometry at an interior of the bone graft.

29. The bone graft of claim 1 wherein the bone graft comprises a surface having a surface composition which is different from a composition at an interior of the bone graft.

30. The bone graft of claim 1 wherein the bone graft comprises a surface having a surface geometry suitable to face natural bone.

31. The bone graft of claim 1 wherein the bone graft comprises a surface having a surface composition suitable to face natural bone.

32. The bone graft of claim 1, further comprising osteoconductive or osteoinductive substances.

33. The bone graft of claim 1, further comprising substances from a patient's own blood or other biological substances or demineralized bone matrix.

34. The bone graft of claim 1, further comprising a polymer.

35. The bone graft of claim 34 wherein the polymer is a comb polymer.

36. The bone graft of claim 34 wherein the polymer is resorbable.

37. The bone graft of claim 34 wherein the polymer is non-resorbable.

38. The bone graft of claim 1 wherein the bone graft is sterile.

39. The bone graft of claim 1 wherein the bone graft is manufactured at least in part by three dimensional printing.

40. A method of installing a bone graft to augment a sinus, comprising: resecting gingiva; cutting a window in a buccal cortical plate to access the sinus; and installing, in the sinus, a bone graft comprising synthetic material or demineralized bone matrix in a rigid form.

41. The method of claim 40 wherein the bone graft has patient-specific dimensions prior to surgery.

42. The method of claim 40, further comprising, after the cutting of the window but before the installing of the bone graft, removing tissue contained within the sinus.

43. The method of claim 40, further comprising, after the cutting of the window but before the installing of the bone graft, removing a septum of the sinus.

44. The method of claim 40, further comprising, after the cutting of the window but before the installing of the bone graft, cutting within the sinus using a bone-cutting tool which is capable of cutting bone.

45. The method of claim 40, further comprising, after the cutting of the window but before the installing of the bone graft, cutting within the sinus using a bone-

cutting tool which is capable of cutting bone and a non-bone-cutting tool which is incapable of cutting bone but capable of cutting soft tissue.

46. The method of claim 40, further comprising, after the cutting of the window but before the installing of the bone graft, applying antiseptic and/or antibiotic.

47. The method of claim 40, further comprising, after the cutting of the window but before the installing of the bone graft, applying a formable filler material between the bone graft and the sinus.

48. The method of claim 40 wherein the bone graft comprises more than one part, all of which parts fitting together to form the bone graft, and wherein the installing of the bone graft comprises bringing in the parts in succession.

49. The method of claim 40, further comprising, after installing the bone graft, attaching the bone graft.

50. The method of claim 40, further comprising, after the installing of the bone graft, installing an implant base through the maxilla and into the bone graft.

51. The method of claim 50 wherein installing the implant base comprises using an implant base template which is unique to a particular patient.

52. The method of claim 51 wherein at least one dimension of the implant base template is determined using radiographic data.

53. The method of claim 40, further comprising, after installing the bone graft, applying a surgical membrane.

54. The method of claim 40, further comprising, after all of the other steps, putting the resected gingiva back in place.

55. The method of claim 40 wherein cutting the window is performed using a window template which is unique to a particular patient.

56. The method of claim 55 wherein at least one dimension of the window template is determined using radiographic data.

57. A method of installing a bone graft to augment a sinus, comprising: resecting gingiva; cutting a window in a buccal cortical plate using a patient-unique window template; and installing, in the sinus, a filler.

58. The method of claim 57 wherein at least one dimension of the patient-unique window template is determined using radiographic data.

59. The method of claim 57 wherein the filler is a formable material.

60. The method of claim 57 wherein the filler is a bone graft comprising a rigid material.

61. The method of claim 60 wherein the bone graft comprises synthetic material.

62. The method of claim 60 wherein the bone graft comprises demineralized bone matrix.

63. The method of claim 60 wherein the bone graft has at least one dimension which is selected based on characteristics of a particular site in a particular patient.

64. The method of claim 60 wherein the bone graft has at least one dimension which is selected based on a dimension of an implant base.

65. The method of claim 60 wherein the window template has at least one dimension which is selected based on a dimension of the bone graft.

66. The method of claim 60, further comprising, after the cutting of the window but before the installing of the bone graft, removing tissue contained within the sinus.

67. The method of claim 60, further comprising, after the cutting of the window but before the installing of the bone graft, removing a septum of the sinus.

68. The method of claim 60, further comprising, after the cutting of the window but before the installing of the bone graft, applying antiseptic and/or antibiotic.

69. The method of claim 60, further comprising, after the cutting of the window but before the installing of the bone graft, applying a formable filler material between the bone graft and the sinus.

70. The method of claim 60, further comprising, after installing the bone graft, attaching the bone graft.

71. The method of claim 60, further comprising, after the installing of the bone graft, installing an implant base through the maxilla and into the bone graft.

72. The method of claim 60 wherein installing the implant base comprises using an implant base template which is unique to a particular patient.

73. The method of claim 72 wherein at least one dimension of the implant base template is determined using radiographic data.

74. The method of claim 57, further comprising, after installing the bone graft, applying a surgical membrane.

75. The method of claim 57, further comprising, after all of the other steps, putting the resected gingiva back in place.

76. A method of installing a bone graft to augment a sinus, comprising: resecting gingiva; cutting a window in a buccal cortical plate to access the sinus; and installing, in the sinus, a rigid bone graft; and installing an implant base in the maxilla and the bone graft using an implant base template which is unique to a particular patient.

77. The method of claim 76 wherein at least one dimension of the implant base template is determined using radiographic data.

78. The method of claim 76 wherein the bone graft has at least one dimension which is selected based on characteristics of a particular site in a particular patient.

79. A method of manufacturing a bone graft for augmenting a sinus, comprising spreading successive layers of a powder and three dimensionally printing an article suitable to at least approximately fit the dimensions of a portion of the sinus.

80. The method of claim 79, further comprising, before any other steps, obtaining dimensions from radiographic data.

81. The method of claim 79 wherein the powder comprises demineralized bone matrix.

82. The method of claim 79 wherein the powder comprises ceramic.

83. The method of claim 82, further comprising, after the three dimensional printing, heating the article for a combination of temperature and time sufficient to partially sinter the article.

84. The method of claim 79, further comprising, after all the described steps, introducing an additional substance into pores of the article.

85. The method of claim 84 wherein the additional substance comprises substances from the patient's own blood or other biological substances or demineralized bone matrix.

86. An article manufactured by the method of claim 79.

87. A kit for installing a bone graft in a sinus, comprising: at least one bone graft comprising synthetic material or demineralized bone matrix, and at least one cutting tool.

88. The kit of claim 87 wherein the bone graft has bone graft dimensions which are unique to a particular patient.

89. The kit of claim 87 wherein at least one bone graft dimension is coordinated with dimensions of the sinus.

90. The kit of claim 87, further comprising a patient-unique window template suitable to guide a cutting of a window in a buccal cortical plate.

91. The kit of claim 87, further comprising at least one bone-cutting tool capable of cutting bone and at least one non-bone-cutting tool which is incapable of cutting bone but capable of cutting soft tissue.

92. The kit of claim 87, further comprising a patient-unique implant base template suitable to guide an installing of an implant base.

93. The kit of claim 87, further comprising at least one implant base, and at least one drill for preparing a site for the implant base, and a tool for installing the implant base.

94. The kit of claim 87, further comprising at least one additional article selected from the group consisting of: a carrier for gripping the bone graft, surgical screws, tools for installing surgical screws, formable filler material, antiseptics, antibiotics, a surgical membrane, and sutures.

95. The kit of claim 87 wherein at least some articles in the kit are sterile.